

Unio sella and *U. sula*: A review of enigmatic taxonomic names linked to *Gibbosula laosensis* (Lea, 1863) (Bivalvia: Margaritiferidae: Gibbosulinae)

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Abstract. The Indochinese freshwater pearl mussel *Gibbosula laosensis* is a little-known but endangered species with a disjunctive range in the Mekong and Sittaung drainage basins. Here we provide an overview of two taxonomic names, i.e., *Unio sella* and *U. sula* that were linked to *Gibbosula laosensis*. We show that the name *Unio sella* has been introduced by Cesare Maria Tapparone-Canefri on the labels of at least two shell lots, which were collected by Leonardo Fea during his travel to the Karen Hills in British Burma in the years 1887–1888. However, Tapparone-Canefri did not publish this name for unknown reasons. Fritz Haas mentioned this name in the year 1912 as an unpublished name and a synonym of *Gibbosula laosensis* based on a study of two specimens of the latter species from the Natural History Museum Vienna (NHMW). Ten years later, Bains Prashad also provided a description of what he accepted as *Unio sella*, but he used a series of four shells from the Museo Civico di Storia Naturale di Genova (MSNG) that contained two specimens of *Yaukthwa nesemanni* and two specimens of *Gibbosula laosensis*. Prashad followed the handwritten labels of Tapparone-Canefri and considered the sample of the first species as young specimens of *Unio sella*, while *Gibbosula laosensis* specimens have been treated by him as adult shells of this taxon. To retain the concept of *Unio sella* published by Prashad, we designate a specimen of *Yaukthwa nesemanni* that was among Tapparone-Canefri's series in MSNG to be the lectotype of *U. sella* Prashad, 1922. Hence, there are two different taxa under the name *Unio sella*, i.e., *U. sella* Haas, 1912, a synonym of *Gibbosula laosensis* (Margaritiferidae: Gibbosulinae), and *U. sella* Prashad, 1922, a primary junior homonym of Haas's taxon and a senior synonym of *Yaukthwa nesemanni* (Unionidae: Rectidentinae). However, in both cases this name is initially unavailable, because it was introduced as a synonym and was never used as a valid name (Art. 11.6 of the International Code of Zoological Nomenclature). Finally, the name *Unio sula* Simpson, 1900 nom. nudum seems to have originated through an incorrect spelling of *U. sella* Prashad, 1922, because “sella” is written like “sula” on the original label of *Yaukthwa nesemanni* sample in MSNG.

Key words. Myanmar, Margaritiferidae, Unionidae, Cesare Maria Tapparone-Canefri, Fritz Haas, Bains Prashad, Leonardo Fea

INTRODUCTION

The systematics of freshwater bivalves in the Oriental Region is complicated by the presence of numerous nominal taxa with unclear taxonomic status that have been introduced on the basis of brief and incomplete descriptions (Simpson, 1900; Prashad, 1922; Brandt, 1974; Subba Rao, 1989; Zieritz et al., 2018). Recent re-analysis of such taxa often leads to shifts in their taxonomic position and, sometimes, to dramatic changes in the higher-level taxonomy of freshwater bivalves (Bolotov et al., 2017a, 2018a; Konopleva et al., 2017, 2019; Lopes-Lima et al., 2017, 2018; Pfeiffer et al., 2018). For example, the freshwater pearl mussel subfamily Gibbosulinae Bogan, Bolotov, Froufe & Lopes-Lima in Lopes-Lima et al., 2018 (Margaritiferidae Henderson, 1929) has recently been discovered based on the reassessment of the taxonomic position of *Gibbosula crassa* (Wood, 1815) from northern Vietnam and *G. rochechouartii* (Heude, 1875) from China (Huang et al., 2018; Lopes-Lima et al., 2018).

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Gibbosula laosensis (Lea, 1863), another member of the Gibbosulinae, is one of a few tropical margaritiferid species, which was recorded from several distant localities in Laos, Thailand, Vietnam, and Myanmar (Brandt, 1974; Graf & Cummings, 2007; Bolotov et al., 2014, 2016; Araujo et al., 2017; Do et al., 2018; Lopes-Lima et al., 2018). Simpson (1900) introduced *Unio sula*, an enigmatic taxonomic name, as a synonym of *Gibbosula laosensis*. Haas (1912) described two mussel specimens that “seem to be an extremely thick-shelled” *Gibbosula laosensis* collected from Burma by Leonardo Fea, a famous Italian traveler and naturalist, under the name *Unio sella*, which was written on the original label of this sample. This name was introduced by Haas (1912) as a synonym of *Gibbosula laosensis*. Haas (1912) mentioned that the name *Unio sella* was originally used by Cesare Maria Tapparone-Canefri, a prominent Italian malacologist, but was never published. Later, Prashad (1922) described a series of four freshwater mussel specimens collected by Fea as *Unio sella* and noted that they are ‘referable’ to *Gibbosula laosensis*. The subsequent authors have included one or both those names to the synonymy of *Gibbosula laosensis* (e.g., Haas, 1969; Brandt, 1974), but nobody has tried to uncover the complete history of the names *Unio sella* and *U. sula* and to reexamine the shell lots of *Unio sella*. However, *Gibbosula laosensis* is an endangered species, and its synonymy needs to be carefully revised to improve our knowledge on the distribution range of this mussel and to develop a conservation action plan for surviving local populations (Ferreira-Rodríguez et al., 2019).

The present paper aims to revise the name *Unio sella* by means of a conchological study of available specimens and their original labels in museum collections with a supplement of the results of recent field works in the Karen Hills area, Myanmar. We also reconsider the status of the name *Unio sula* and provide a hypothesis on its origin. This work is a part of a large research project focused on a broad-scale taxonomic revision of freshwater bivalves in Southeast Asia (Konopleva et al., 2017, 2019; Bolotov et al., 2017a, b, 2018a, b; Do et al., 2018; Lopes-Lima et al., 2018).

MATERIAL AND METHODS

We examined two shell lots of *Unio sella* in the Natural History Museum Vienna (NHMW), Vienna, Austria and the Museo Civico di Storia Naturale di Genova (MSNG), Genova, Italy. The shells and labels were photographed using Canon EOS 7D DSLR camera (Canon Inc., Japan). The Tapparone-Canefri’s shell lots do not have any accession numbers because a systematic catalogue for this collection in MSNG is still lacking.

A body of available historical literature was reviewed, including the field notes of Leonardo Fea, who collected the shell lots of *Unio sella* during his travel to the Karen Hills, Burma (Fea, 1888). The Karen Hills, or Kayah-Karen Mountains, is a large highland area in eastern Myanmar. However, Fea had viewed the Karen Hills as a more restricted area, which contains freshwater basins of two tributaries of

the Sittaung River (Thauk Ye Kupt and Paunglaung rivers) and the Nam Pawn River, a tributary of the Salween River (Fig. 1).

We reconstructed the route of Fea’s travel using his field diary with a supplementary map (Fea, 1888) and a location of mountain paths in the area (topographic map no. E47-1, The General Staff of the USSR, scale = 1:500,000, <https://order.cgkipd.ru>). Based on this reconstruction, we revisited the river systems of the Karen Hills crossed by Fea (Figs. 1, 2). Our own field works in the Karen Hills were conducted in the years 2015–2018.

The map of the Karen Hills area with the boundaries of freshwater subregions, collecting localities and historical information (Fig. 1), was created using ArcGIS 10 with a high-resolution geography data set combined from Esri Data & Maps and the following data bases in the public domain: WDBII – CIA World Data Bank II (www.evl.uic.edu/pape/data/WDB), OpenStreetMap (www.openstreetmap.org), HydroBASINS (www.hydrosheds.org/page/hydrobasins), and Natural Earth Data (www.naturalearthdata.com).

The newly collected samples are deposited in the Russian Museum of Biodiversity Hotspots (RMBH), Federal Center for Integrated Arctic Research of the Russian Academy of Sciences, Arkhangelsk, Russia, and North Carolina Museum of Natural Sciences (NCSM), Raleigh, United States of America.

RESULTS

Shell lots of *Unio sella*. Two shell lots of freshwater mussels labelled “*Unio sella*” were examined. We found that the shell lot in NHMW contains two specimens of *Gibbosula laosensis* (Margaritiferidae: Gibbosulinae) (Fig. 3A–E), while the lot with a single shell in MSNG belongs to *Yaukthwa nesemanni* (Konopleva, Vikhrev & Bolotov in Bolotov et al., 2017a) (Unionidae: Rectidentinae: Contradentini) (Fig. 4A–F). Prashad (1922) illustrated two shells of *Gibbosula laosensis* and two shells of *Yaukthwa nesemanni* and noted that these shells were received from MSNG. One of *Yaukthwa nesemanni* shells illustrated by Prashad (1922: Fig. 1, Pl. 2) represents the MSNG lot studied by us.

Results of recent field survey in the Karen Hills. This area can be subdivided into two freshwater subregions, i.e., western Karen Hills and eastern Karen Hills (Fig. 1). The first subregion includes the rivers and streams belonging to the two tributaries of the Sittaung River: Thauk Ye Kupt River (flowing in southwestern direction) and Kyan Hone River, a tributary of the Paunglaung River (flowing in northern direction). The eastern Karen Hills contains the freshwater systems of the Nam Pawn Basin, a tributary of the Salween River.

Both *Gibbosula laosensis* and *Yaukthwa nesemanni* were rediscovered by us from the headwater of the Thauk Ye Kupt River, Sittaung Basin, western Karen Hills (Figs. 1,

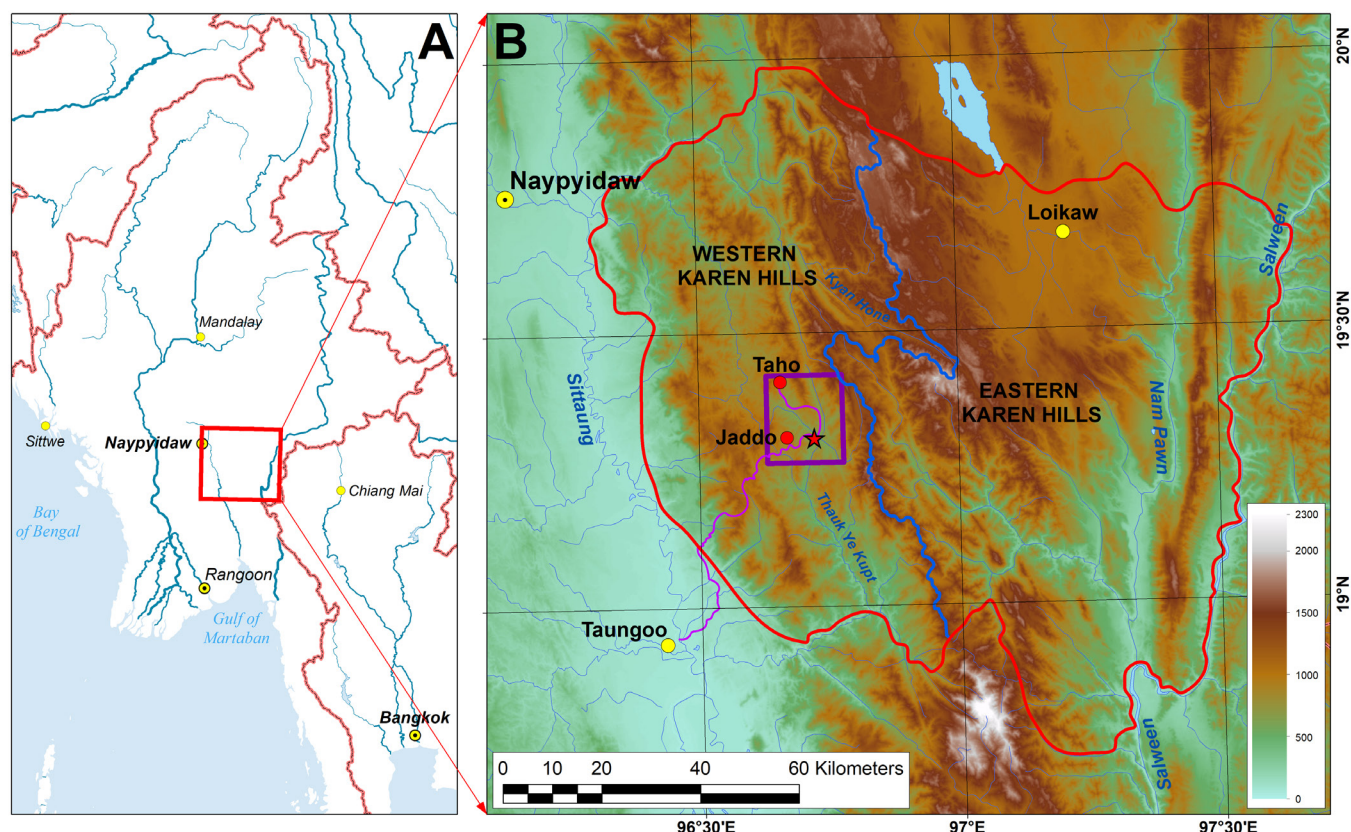


Fig. 1. Karen Hills area. A, map of Myanmar with the geographic position of the Karen Hills area (red frame); B, map of the Karen Hills area with the boundaries of freshwater subregions, collecting localities and historical information. The red line indicates boundary of the Karen Hills area sensu Leonardo Fea (1888). The blue line indicates the Sittaung – Salween drainage divide, separating the western and eastern subregions of the Karen Hills area. The violet line indicates the putative route of Leonardo Fea’s expedition in the years 1887–1888 (Fea 1888; topographic map no. E47-1 by The General Staff of the USSR, scale = 1:500,000). The red star indicates our locality on the Thauk Ye Kupt River, from which *Unio sella* Haas, 1912 [= *Gibbosula laosensis*] and *U. sella* Prashad, 1922 [= *Yaukthwa nesemanni*] were rediscovered. The red circles indicate two highland research stations of Leonardo Fea in the western Karen Hills: “Jaddo (Yado) Valley” (ca. 30 mi NE of Taungoo, alt. ca. 900–1,000 m a.s.l.), and “Taho (Thao) village” (ca. 7–8 mi N of “Jaddo Valley”, alt. ca. 1,200–1,300 m a.s.l.) (Fea, 1888). The purple frame indicates the boundary of area in which the type localities of *Unio sella* Haas, 1912 [= *Gibbosula laosensis*] and *U. sella* Prashad, 1922 [= *Yaukthwa nesemanni*] were situated. (Map: Mikhail Yu. Gofarov).

2, 3F, G, 4G, H). The Thauk Ye Kupt Basin represents a system of mountain rivers and streams with fast current and numerous riffles and runs (Fig. 2). From the Kyan Hone River, *Gibbosula laosensis* and another *Yaukthwa* species, *Y. panhai* (Konopleva, Bolotov & Kondakov in Bolotov et al., 2017a), were recorded. No freshwater mussels were found in the water courses of the eastern Karen Hills subregion (Salween Basin).

DISCUSSION

Re-analysis of the shell lots labelled “*Unio sella*”. This name was introduced by Cesare Maria Tapparone-Canefri on the labels of at least two lots of freshwater mussel shells [no. 20080 in NHMW and unnumbered lot in MSNG] collected by Leonardo Fea from the Karen Hills, Burma (Figs. 3, 4), but he did not publish this name for unknown reasons. No samples from the Karen Hills were discussed in his large work on the Burmese Unionidae (Tapparone-Canefri, 1889), probably because those shells arrived in Italy after publication of the manuscript.



Fig. 2. Thauk Ye Kupt River, western Karen Hills, proposed type locality for *Unio sella* Haas, 1912 [= *Gibbosula laosensis*] and *U. sella* Prashad, 1922 [= *Yaukthwa nesemanni*]. (Photo: Ilya Vikhrev).

Haas (1912) mentioned the name *Unio sella* for the first time, providing a reference to the two specimens from NHMW that he examined. Haas (1912: 123) stated that: “Among the molluscs brought by Fea from Burma are also *Unio sella*, which Tapparone Canefri never described, but which

was cited in Fea's sales list. Through kind support of Dr. R. Sturany I have received from the K. K. Hofmuseum in Vienna, which owns the Fea's molluscs, two specimens of this *Unio sella* to examination, which seem to be extremely thick-shelled *Margaritanopsis laosensis* and which I will later depict with other supplements". Actually, both specimens from the NHMW collection examined by Haas (1912) belong to *Gibbosula laosensis* (Fig. 3A–E), and *Unio sella* Haas, 1912 is undoubtedly a junior synonym of this species. Moreover, it should be considered an unavailable name, because *Unio sella* Haas, 1912 was introduced as a synonym of *Gibbosula laosensis* and was never used as valid (Art. 11.6 of the International Code of Zoological Nomenclature [ICZN thereafter]).

Ten years later, Prashad (1922: 93) obtained four shells from the MSNG, which, as he believed, were representatives of *Unio sella*, and noted that: "...they beautifully illustrate the changes that take place in the structure of the hinge during the growth of the young into the adult shell, changes which appear to be characteristic to the genus". However, Prashad (1922) examined the shells of two different species, i.e., *Yaukthwa nesemanni* ("young shells", Figs. 1, 2, Pl. 2 in Prashad, 1922) and *Gibbosula laosensis* ("adult shells", Figs. 3, 4, Pl. 2 in Prashad, 1922). It becomes clear from his pictures and the following description: "The young shells [= *Yaukthwa nesemanni*] are somewhat rhomboidal and only show a beginning of the arcuate outline of the ventral margin of the adult shells. They are thin and not at all solid. The pseudocardinals in the right valves of the young shells are lamellar, thin, and lie one above the other; in the adult shell [= *Gibbosula laosensis*] the upper or anterior becomes very thick, somewhat knob-like and lies just next to the scar of the anterior adductor muscle, the lower (or now the posterior) comes to be more or less in line with the anterior and is separated from it by a fairly deep groove, it now takes the form of an elongated ridge with its anterior edge raised into a trigonal tooth-like structure. In the left valve there is a single lamellar pseudocardinal in the young shells [= *Y. nesemanni*], but in the adult [= *G. laosensis*] it becomes very thick and divided into two parts – an anterior smaller and somewhat trigonal and a posterior much larger and conical, for interlocking with the teeth of the other valve" (Prashad, 1922: 93). Here we designate the *Yaukthwa nesemanni* specimen labeled "*Unio sella*" from MSNG (Fig. 4A–C) to be the lectotype of *U. sella* Prashad, 1922 to retain the concept of this taxon introduced by Prashad (1922). As Prashad (1922) used the shell lots with Tapparone-Canefri's original labels, this 'mixed' concept seems to correspond to the original point of view on *Unio sella*. However, *Unio sella* Prashad, 1922 is also not an available name, because it was initially introduced as a synonym of *Gibbosula laosensis* and was never used as valid (Art. 11.6 of ICZN).

Putative type localities of *Unio sella* Haas, 1912 and *U. sella* Prashad, 1922. On his labels, Leonardo Fea often indicated vague localities, exact geographic positions of which are unclear (Hallermann et al., 2002). This is also the case for the samples of both *Unio sella* Haas, 1912 and *U. sella* Prashad, 1922, with the labels "Mti Carin 1,300

m, Birmanien" and "Carin independ. 1,000–1,200 m", respectively (Figs. 3E, 4D).

Fea's route and main collecting stations in the Karen Hills were briefly described in his field notes with a supplementary map (Fea, 1888). Our own field work revealed that the samples of "*Unio sella*" were likely collected from the western Karen Hills subregion (Sittaung Basin), because *Gibbosula laosensis* (= *U. sella* Haas, 1912) and *Yaukthwa nesemanni* (= *U. sella* Prashad, 1922) were rediscovered in the headwater of the Thauk Ye Kupt River (Bolotov et al., 2017a; Bolotov et al., unpubl. data) (Fig. 1). Additionally, *Gibbosula laosensis* and *Yaukthwa panhai* were collected by us from the Kyan Hone River, a tributary of the Paunglaung River (Bolotov et al., 2017a), but this latter basin was not illustrated on Fea's map (Fea, 1888: Fig. 1), and he probably did not even cross this water course.

In the western Karen Hills, Fea founded two highland research stations: "Jaddo (Yado) Valley" (ca. 30 mi NE of Taungoo, alt. ca. 900–1000 m a.s.l.) and "Taho (Thao) village" (ca. 7–8 mi N of "Jaddo Valley", alt. ca. 1,200–1,300 m a.s.l.) (Fig. 1). Both stations were situated within the Thauk Ye Kupt Basin, and it is likely that the shells of "*Unio sella*" were collected by Fea somewhere around those stations or on the way between them, within an area marked on the map (Fig. 1).

Review of the name *Unio sula*. Simpson (1900) published this name as a synonym of *Gibbosula laosensis* with a vague reference to Theobald lacking an exact source and date of publication. Haas (1912) assumed that this *Unio sula* may be identical to *U. sella*. We agree with Haas's hypothesis and suggest that this name originated in an incorrect spelling of the name *Unio sella*, as on the original label of the lectotype of *Unio sella* Prashad, 1922 in MSNG, "sella" is written like "sula" (Fig. 4D). The reference to Theobald in Simpson (1900) may have originated from the same label, because "Tapp." [Tapparone] is written unclear and could be read as "Thld" [Theobald]. In summary, *Unio sula* Simpson, 1900 must be considered a *nomen nudum* because it does not have a description, reference or indication and fails to conform to Article 12 of ICZN.

TAXONOMY

Unio sella Haas, 1912 (Fig. 3A–G)

- Unio sella* Haas, 1912: 122.
Unio laosensis Lea, 1863: 67.
Margaritana laosensis – Simpson, 1900: 678.
Margaritanopsis laosensis – Haas, 1910: pl. 12.
Margaritifera laosensis – Haas, 1969: 13.
Gibbosula laosensis – Lopes-Lima et al., 2018: 112.

Taxonomic status. This name was introduced as a synonym of *Gibbosula laosensis* (Margaritiferidae: Gibbosulinae) (Haas, 1912) and was never used as valid. Therefore this

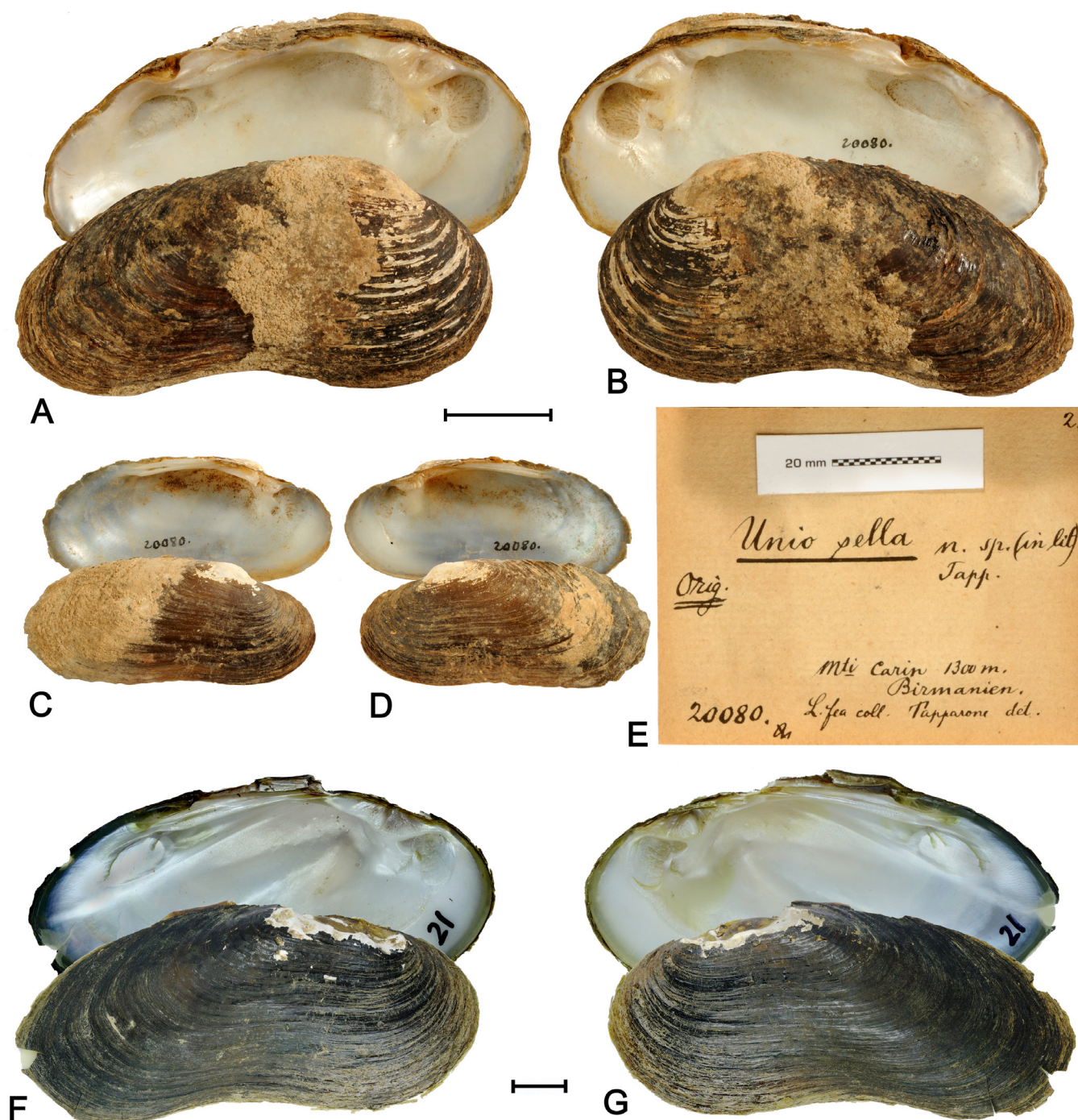


Fig. 3. Types of *Unio sella* Haas, 1912 [= *Gibbosula laosensis*] (NHMW 20080) and proposed topotype of this taxon (RMBH biv136/21). A, B, lectotype [designated in this study], larger shell, lateral view. A, inner side of the left valve and outer side of the right valve; B, vice versa. C, D, paralectotype, smaller shell, lateral view. C, inner side of the left valve and outer side of the right valve; D, vice versa. Scale bar = 20 mm. E, original label [probably by C.M. Tapparone-Canefri]. F, G, shell of proposed topotype from Thauk Ye Kupt River, lateral view. F, inner side of the left valve and outer side of the right valve; G, vice versa. Scale bar = 10 mm. (Photos: NHMW/A. Schumacher, with permission of Anita Eschner [A–E] and Ekaterina Konopleva [F–G]).

name is not available (Art. 11.6 of ICZN). A junior synonym for *Gibbosula laosensis*.

Type locality. “Mti Carin 1300 m, Birmanien” [headwater of the Thauk Ye Kupt River, Sittaung Basin, western Karen Hills area, Myanmar] (Figs. 1, 2).

Type series. Lectotype [larger shell, designated in this study] and paralectotype [smaller shell], NHMW no. 20080 (Fig.

3A–D). Original label: “20080. Orig. 2. *Unio sella* Tapp. n. sp. (in lit.). Mti Carin 1300 m, Birmanien. L. Fea coll., Tapparone det.” (Fig. 3E). This sample is not dated, but Fea was collecting on the Karen Hills area during the period from 13 December 1887 to 11 April 1888 (Fea, 1888).

Other samples (proposed topotypes). Two shells of *Gibbosula laosensis* illustrated by Prashad (1922): Pl. 2, Figs. 3, 4; their current whereabouts are unknown (but see

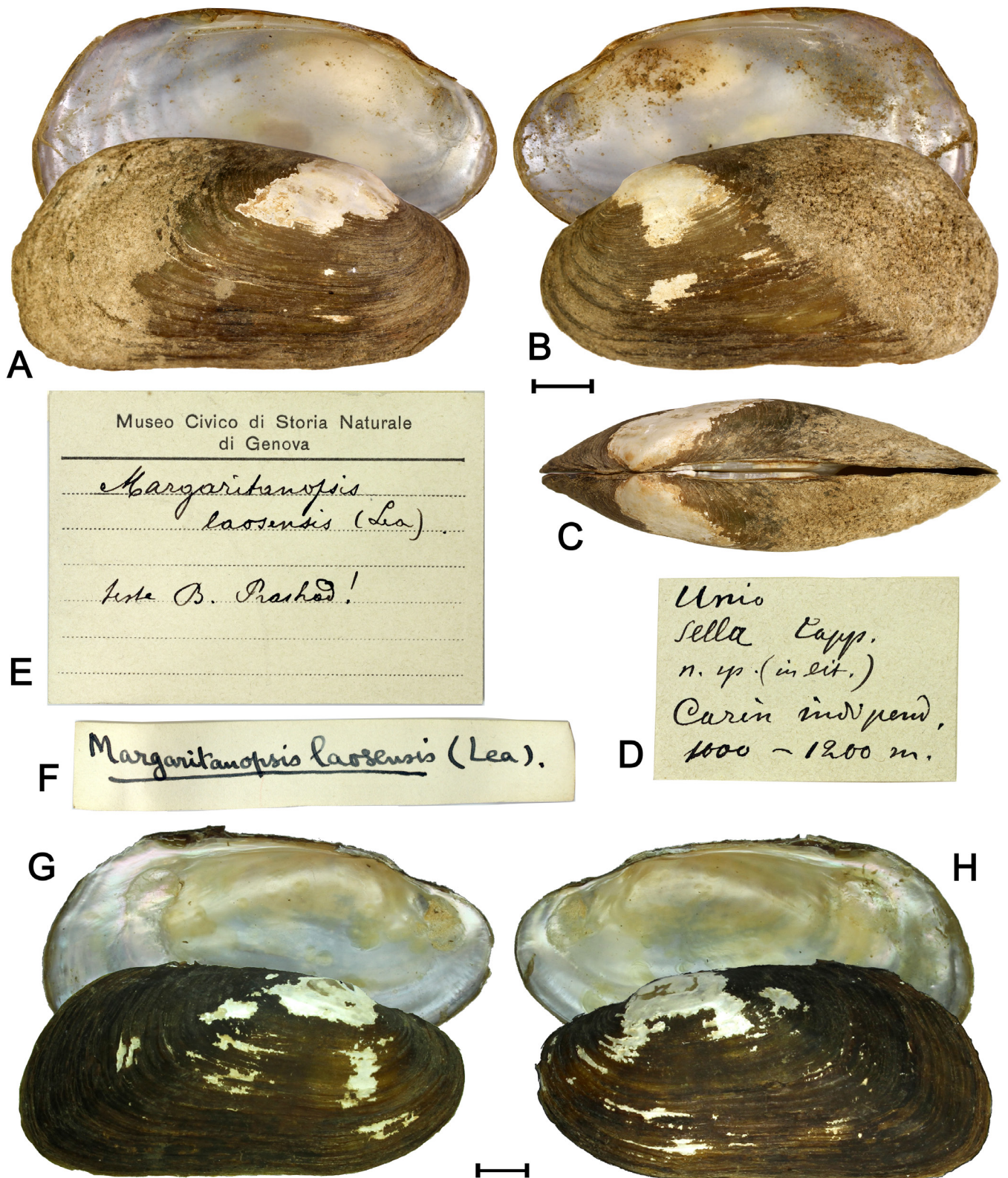


Fig. 4. Lectotype of *Unio sella* Prashad, 1922 [= *Yaukthwa nesemanni*] (MSNG, without ID number) and proposed topotype of this taxon (NCSM 103033). A, B, lectotype [designated in this study], lateral view. A, inner side of the left valve and outer side of the right valve; B, vice versa. C, lectotype, dorsal view. Scale bar = 5 mm. D, original label of the lectotype [probably by C.M. Tapparone-Canefri]. E, F, secondary labels of the lectotype [probably by B. Prashad]. G, H, shell of proposed topotype from Thauk Ye Kupt River, lateral view. G, inner side of the left valve and outer side of the right valve; H, vice versa. Scale bar = 10 mm. (Photos: Ilya Vikhrev [A-F] and Ekaterina Konopleva [G-H]).

discussion on the paratype of *Unio sella* Prashad, 1922). Recent samples of *Gibbosula laosensis*: 5 ethanol-preserved specimens, 55 dead shells and 28 dry valves, Myanmar: Sittaung Basin, Thauk Ye Kupt River, 19.3075° N, 96.7219° E, 20 April 2015, coll. Bolotov, Vikhrev and local villagers [RMBH biv136]; 3 ethanol-preserved specimens, same locality, 7 December 2016, coll. Vikhrev [RMBH biv271].

Etymology. The Latin (and Italian) word “sella” means “saddle”, most likely a reference to the arcuate shell shape of this species.

Unio sella Prashad, 1922

(Fig. 4A–H)

Unio sella Prashad, 1922: 93, pl. 2, figs. 1, 2.

Trapezoideus nesemanni Konopleva, Vikhrev & Bolotov in Bolotov et al., 2017a: 13, fig. 4c, tables 3, S1.

Yaukthwa nesemanni – Konopleva et al., 2019: 7.

Taxonomic status. This name was introduced as a synonym of *Gibbosula laosensis* (Margaritiferidae: Gibbosulinae) (Prashad, 1922) and was never used as valid. Therefore this name is not available (Art. 11.6 of ICZN). A primary junior homonym of *Unio sella* Haas, 1912 and a senior synonym for *Yaukthwa nesemanni* (Unionidae: Rectidentinae: Contradentini).

Type locality. “Carin independ. 1000–1200 m” [headwater of the Thauk Ye Kupt River, Sittaung Basin, western Karen Hills area, Myanmar] (Figs. 1, 2).

Type series. Lectotype in MSNG [designated in this study], without ID number (Fig. 4A–C). Original label: “*Unio sella* Tapp. n. sp. (in lit.). Carin independ. 1000–1200 m” (Fig. 4D). Secondary labels: “*Margaritanopsis laosensis* (Lea). detto B. Prashad” and “*Margaritanopsis laosensis* (Lea).” (Fig. 4E, F). This shell was illustrated by Prashad (1922): Pl. 2, Fig. 1. The sample is not dated, but Fea was collecting in the Karen Hills during the period from 13 December 1887 to 11 April 1888 (Fea 1888). Paralectotype: illustrated by Prashad (1922): Pl. 2, Fig. 2, but its current whereabouts are unknown. Prashad (1922: 92) noted that “I applied to Dr. R. Gestro of the Genoa Museum. He was not only kind enough sent me the whole of Fea’s Burmese collection on loan, but also generously presented to the Indian Museum specimens of a number of the species, duplicates of which were still available”. Based on this note, we could assume that the paralectotype of *Unio sella* Prashad, 1922 is deposited in the malacological collection of the Zoological Survey of India, Kolkata.

Other samples (proposed topotypes). Holotype of *Yaukthwa nesemanni*: Myanmar: Sittaung Basin, Thauk Ye Kupt River, 19.3075° N, 96.7219° E, 26 November 2016, coll. Vikhrev [NCSM 103033]. Paratypes of *Yaukthwa nesemanni*: 4 specimens, same locality, 20 April 2015 and 26 November 2016, coll. Bolotov, Vikhrev and local villagers [RMBH biv255_3, biv144_14, biv144_25, and biv144_19].

Unio sula Simpson, 1900

Unio sula Simpson, 1900: 678; Haas, 1912: 122; Simpson, 1914: 521; Brandt, 1974: 260.

Taxonomic status. *Nomen nudum*, probably an incorrect spelling of the name *Unio sella* Prashad, 1922 (see Fig. 4D and Discussion).

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